The advantages of specifying Cellular Concrete as a compacted fill replacement in the construction or repair of State Roadways and highways

Cellular Concrete has been recognized as the most cost effective replacement for conventional compacted fill by engineering firms across the country.

One of the types of cellular concrete is a light weight fill material that replaces conventional compacted soil. By eliminating the need to compact each lift of soil placed while also reducing truck traffic to the site we save time, save money and we help save the environment by reduced air pollution. The cellular fill material is produced on site and poured into place as a liquid. This material can be placed in 3’ lifts and is at 100% compaction at set. The density can be designed from 25pcf to 100pcf and strength from 150psi to 3000psi.

The time to pour 3” high lift with 100% compaction compared to compacting by hand the same area in 12” lifts to 95% compaction is significant. The cost savings in materials and labor time are also significant.

Not only are the cost lower when using cellular concrete but the time to complete the overall project can be significantly reduced as well providing a much longer lasting solution.

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Summary of Road Design Concepts.

Foam concrete has been used successfully in (road) construction around the world, for a number of years. This versatile material is highly suitable for all kinds of civil engineering applications. Its various volumetric masses of between 250 and 1,600 Kg/m^3, compressive strengths of between 0.2 and 12.0 N/mm^2, rigidity, thermal insulation and water absorption properties in particular, promote its application in tailor-made structures.

Advantages of using foam concrete for road construction and/or sub-base repair:

- **Ease and speed of placement**

When judged against other more labor/time intensive methods, the ability to produce quantities of up to 400m^3 a day means that construction times can be significantly reduced, with consequent cost savings.

- **Total void-fill**

The flowing, self-compacting properties of foam concrete mean that you can be assured that all voids are completely eliminated.

- **Eliminated lateral pressure to the retaining wall**

As the foam concrete hardens it removes all lateral pressure of material above to the side walls and retaining walls of the roadway, this removal of direct pressure against the sides of the roadway increases the longevity of the roadway

- **Susceptibility to breakdown**

Unlike some synthetic lightweight foams (polystyrene for example), hardened foam concrete is not susceptible to breakdown due to the presence of hydrocarbons, bacteria or fungi. It is insect, rodent and fireproof.

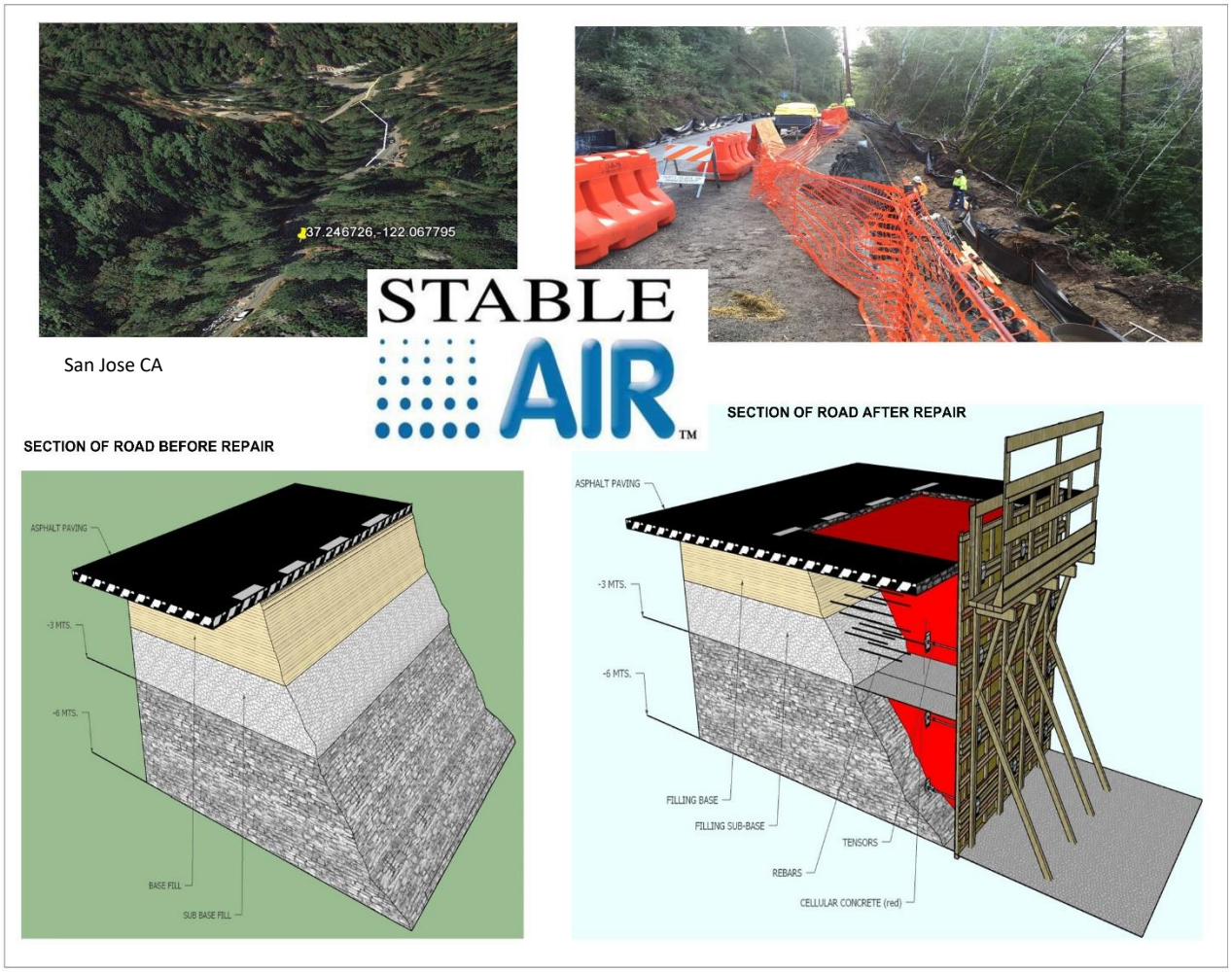
- **Environmentally sound**

Using Foam Concrete on-site batching plant means less traffic disruption both on-site and in the surrounding area. Around 109 Kg/m^3 to 400 Kg/m^3 density lightweight foam concrete can be produced from one bulk powder tanker delivery, making it safer for site-workers and local residents as well as being friendlier to the environment.

- **Principle of Equilibrium**

By replacing the weight of the excavated soil (W1), with a similar or lower combined weight of foam concrete and construction (W2 + W3), the completed structure will be stable and able to resist any subsequent movement of the sub-strata.

Road slope repair using CC as road base w/asphalt as final cover



Cellular Concrete Mix Design

When working with cellular concrete and considering mix designs, a cardinal rule is that as density decreases, so doe's strength. In some instances, such as the material needing to be excavated at a later time, the loss of strength is a benefit. An additional benefit is that as the material becomes lighter, its thermal and acoustic isolative properties increase as well.

A very basic cellular concrete mix design would consist simply of Portland cement, water, and externally generated foam, which is also referred to sometimes as preformed foam. The water cement ratio can typically vary from .40-.80, and the foam content is commonly as high as 80%, depending on desired density.

Typically Type 1 Portland is used; however other Portland types may be used as well. When using other Portland types the benefits for which they're used in other materials also apply to cellular concrete.

Beyond Portland cement, there are many other cementitious materials that may be used in cellular concrete. Fly ash is very common, slag, and silica fume are a few others that have also been used in producing cellular concrete.

Depending on the application, these alternative materials may be used to help increase the strength of the material, or to further improve the economics of cellular concrete, among other reasons. In addition to cementitious materials, other materials can be used as well, such as fiber.

Typically, when densities are below 50 pounds per cubic foot (PCF) (800.92 kg/m³) there are no fine or coarse aggregates used, as they tend to further decrease the strength. When above 50 PCF (800.92 kg/m³) sand may be introduced, primarily as a measure of economics.

Portland is the most expensive component of cellular concrete—and when higher densities are required such as to displace water, but higher strength is not needed—it creates a good opportunity and reason to use cheap filler such as sand.

Coarse aggregates won't typically be introduced until densities are above 100 PCF (1601.85 kg/m³). In applications where cellular concrete is being used in this density range it's more likely to be a structural or precast application.

Pouring Cellular Concrete as with any concrete product, cellular concrete mix designs are particularly important because the mix design is critical to the performance of the material, relative to the application. Once a mix design is decided upon, it's also critical the density when produced is monitored closely.

If the material being produced is too heavy, production yield and money is being lost. If the material is too light, it may not have the required strength for the application.

The water cement ratio of cellular concrete can vary widely. Although most people don't pay much attention to it, it should be noted that the water cement ratio of cellular slurry does increase over the base slurry W/C ratio, due to the water in the foam that's being added.

As with any cementitious product, the strength of cellular concrete will increase at any given density when a lower W/C ratio is used. A general range would be .40-.80, with many mix designs falling more commonly between .50 and .65.

Typically, the water concrete ratios W/C ratios should not be lower than .35. When W/C ratios fall below .35 the slurry can pull water from the foam when it's added, causing the foam bubbles to collapse.

However high shear mixers, such as colloidal mixers, and/or the use of water reducers and super plasticizers can be used effectively to help avoid this problem and allow the use of lower water cement ratios with good success. When using water reducers or any type of ad-mixture with cellular concrete, testing must be done to ensure there are no adverse reactions between the foam and ad-mix. A typical result of a reaction would be the ad-mix causing the foam bubbles to collapse.

The compressive strength for any given density is one of the common topics that people are interested in. Shown above is a table with expected strengths and insulated values for a variety of cellular concrete densities. The strength will vary based upon myriad factors, including final mix design, foam concentrate, foam generator, and base slurry preparation. As with other cementitious materials, cellular concrete typically has compression testing done at 28 days.

1-a

In this photo (1-a) you can see the roadway has collapsed and the base and sub base were of compacted fill materials. The roadway lacked a retaining wall, likely due to the cost of a conventional retaining wall.

1-b

In photo 1-b we are creating the retaining wall and fill from cellular concrete material which is poured in lifts and is self-supporting as each lift hardens. When the cellular concrete is poured against stone forms it bonds with the material, adding to the strength to the wall.

1-c

In photo (1-c) the final product is a repair with a restored hillside that will last the life of the road and beyond.

Cellular concrete used as a road base or a fill is longer lasting and less expensive compared to the conventional compacted fill material. In new construction as well as in road repair this material is much less time consuming to install than compacted fill and overall less costly.

This material is in use for the following

- Dam repair and construction
- Bridge approaches
- Road base
- Abandoned pipe and tank fill
- Void fill
- Underwater cellular applications for docks and piers
- Annular fill for culverts and pipe relining

Cellular Concrete Technologies is recognized as one of the leading companies in the world knowledgeable in the manufacture and design of cellular concrete equipment, foaming agent and batching machines. Our library of tested LDCC (Low Density Cellular Concrete) mix designs and structural light weight designs is second to none.

Our latest patented devise and system allows for Redy mix providers to deliver this very necessary material to the jobsite with all the protocols in place to certify each batch to meet required specifications.

The inclusion of cellular concrete on the list of materials approved for use in road construction and road repair in all 50 States by the Department of Transportation will help improve the cost burden of building and repairing the states roads.